Saturated Liquid Viscosity Measurements of Ten Binary and Ternary Refrigerant Mixtures

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The saturated liquid viscosities of ten binary and ternary refrigerant mixtures composed of difluoromethane (R32), 1,1,1,2-tetrafluoroethane (R134a), pentafluoroethane (R125), and propane (R290) were measured in a sealed gravitational capillary viscometer with a straight vertical capillary from 250 K to 350 K or to a maximum vapor pressure of 2.5 MPa. The maximum uncertainty of the measurements is estimated at ±2.4 %. The highest contribution to the total uncertainty is that of the saturated liquid and vapor densities of the mixtures since they had to be estimated.

Comparisons with literature viscosity data show agreement within the mutual uncertainty for all but one literature set. Similar agreement is found with predicted viscosities using the extended corresponding states model in NIST Standard Reference Database 23 (REFPROP), except for the mixtures of R32 and R134a with propane. Their viscosity-composition dependences are strongly nonideal due to the polar and nonpolar characters of the pure components. These nonidealities cannot be represented with conventional viscosity "mixing rules" because these do not distinguish between different mechanisms of intermolecular interaction. The present results indicate that viscosity measurements can be used to resolve the contributions of molecular size and shape of the pure components, on one hand, and their polarity, on the other, to the mixture viscosity. The nonideal characteristics of the R32 and R134a mixtures with propane are typical for systems where the polar compound is smaller or similar in size as the nonpolar compound.